USB-1608G Series

Multifunction DAQ Devices
USB-1608G
USB-1608GX
USB-1608GX-2AO

User's Guide

Document Revision 2
April 2012
© Copyright 2012

MEASUREMENT COMPUTING™

Your new Measurement Computing product comes with a fantastic extra —

Management committed to your satisfaction!

Thank you for choosing a Measurement Computing product—and congratulations! You own the finest, and you can now enjoy the protection of the most comprehensive warranties and unmatched phone tech support. It's the embodiment of our mission:

To provide data acquisition hardware and software that will save time and save money.

Simple installations minimize the time between setting up your system and actually making measurements. We offer quick and simple access to outstanding live FREE technical support to help integrate MCC products into a DAQ system.

Limited Lifetime Warranty: Most MCC products are covered by a limited lifetime warranty against defects in materials or workmanship for the life of the product, to the original purchaser, unless otherwise noted. Any products found to be defective in material or workmanship will be repaired, replaced with same or similar device, or refunded at MCC's discretion. For specific information, please refer to the terms and conditions of sale.

Harsh Environment Program: Any Measurement Computing product that is damaged due to misuse, or any reason, may be eligible for replacement with the same or similar device for 50% of the current list price. I/O boards face some harsh environments, some harsher than the boards are designed to withstand. Contact MCC to determine your product's eligibility for this program.

30 Day Money-Back Guarantee: Any Measurement Computing Corporation product may be returned within 30 days of purchase for a full refund of the price paid for the product being returned. If you are not satisfied, or chose the wrong product by mistake, you do not have to keep it.

These warranties are in lieu of all other warranties, expressed or implied, including any implied warranty of merchantability or fitness for a particular application. The remedies provided herein are the buyer's sole and exclusive remedies. Neither Measurement Computing Corporation, nor its employees shall be liable for any direct or indirect, special, incidental or consequential damage arising from the use of its products, even if Measurement Computing Corporation has been notified in advance of the possibility of such damages.

Trademark and Copyright Information

Measurement Computing Corporation, InstaCal, Universal Library, and the Measurement Computing logo are either trademarks or registered trademarks of Measurement Computing Corporation. Refer to the Copyrights & Trademarks section on mccdaq.com/legal for more information about Measurement Computing trademarks. Other product and company names mentioned herein are trademarks or trade names of their respective companies.

© 2012 Measurement Computing Corporation. All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form by any means, electronic, mechanical, by photocopying, recording, or otherwise without the prior written permission of Measurement Computing Corporation.

Notice

Measurement Computing Corporation does not authorize any Measurement Computing Corporation product for use in life support systems and/or devices without prior written consent from Measurement Computing Corporation. Life support devices/systems are devices or systems that, a) are intended for surgical implantation into the body, or b) support or sustain life and whose failure to perform can be reasonably expected to result in injury. Measurement Computing Corporation products are not designed with the components required, and are not subject to the testing required to ensure a level of reliability suitable for the treatment and diagnosis of people.

Table of Contents

Preface
About this User's Guide 5
What you will learn from this user's guide 5
Conventions in this user's guide 5
Where to find more information 5

Chapter 1
Introducing the USB-1608G Series 6
Functional block diagram 7

Chapter 2
Installing a USB-1608G Series Device 8
What comes with your shipment? 8
Hardware 8
Documentation 8
Unpacking 8
Installing the software 9
DAQFlex 9
Universal Library and InstaCal 9
Installing the hardware 9
Calibrating 10
Self-calibration 10
Factory calibration 10
Programming and developing applications 10
Firmware updates 10

Chapter 3
Functional Details 11
Analog input modes 11
Software paced 11
Hardware paced 11
Burst mode 11
External components 12
USB connector 12
LEDs 12
Screw terminals 12
Signal connections 14
Analog input 14
Analog output (USB-1608GX-2AO only) 15
External clock I/O 15
Digital I/O 15
Trigger input 16
Counter input 17
Timer output 17
Power output 17
Ground 17
Mechanical drawings 18

Chapter 4
Specifications 19
Analog input 19
Accuracy 20
Analog input DC voltage measurement accuracy 20
Noise performance 20
Settling time 20

Analog output (USB-1608GX-2AO only) 21
Analog input/output calibration 22
Digital input/output 22
External trigger 22
External clock input/output 23
Counter 23
Timer 24
Memory 24
Power 24
USB 24
Environmental 25
Mechanical 25
Screw terminal connector 25
Differential mode pinout 25
Single-ended mode pinout 26
Declaration of Conformity 27

About this User's Guide

What you will learn from this user's guide

This user's guide describes the Measurement Computing USB-1608G Series data acquisition devices and lists device specifications.

Conventions in this user's guide

For more information about …

Text presented in a box signifies additional information and helpful hints related to the subject matter you are reading.

Caution! Shaded caution statements present information to help you avoid injuring yourself and others, damaging your hardware, or losing your data.

bold text — **Bold** text is used for the names of objects on a screen, such as buttons, text boxes, and check boxes.

italic text — *Italic* text is used for the names of manuals and help topic titles, and to emphasize a word or phrase.

Where to find more information

Additional information about USB-1608G Series hardware is available on our website at www.mccdaq.com. You can also contact Measurement Computing Corporation by phone, fax, or email with specific questions.

- Phone: 508-946-5100 and follow the instructions for reaching Tech Support.
- Fax: 508-946-9500 to the attention of Tech Support
- Email: techsupport@mccdaq.com

Introducing the USB-1608G Series

The USB-1608G Series includes the following devices:

- USB-1608G
- USB-1608GX
- USB-1608GX-2AO

These devices are USB 2.0 high-speed devices that are supported under the following operating systems:

- Microsoft Windows 7/Vista/XP (32-bit or 64-bit)
- Macintosh (32-bit or 64-bit)
- Linux (32-bit or 64-bit)

The USB-1608G Series is compatible with both USB 1.1 and USB 2.0 ports. The speed of the device may be limited when using a USB 1.1 port due to the difference in transfer rates on the USB 1.1 versions of the protocol (low-speed and full-speed).

Each USB-1608G Series device provides the following features:

- 16 single-ended (SE) or eight differential (DIFF) analog input channels
- Eight individually configurable digital I/O channels
- Two counter channels (32-bit) that count TTL pulses
- One timer output channel (32-bit)
- Screw terminals for field wiring connections

The USB-1608GX-2AO also provides two analog output channels. You can pace each channel at rates of up to 500 kS/s per second. You can pace both channels simultaneously at rates of up to 250 kS/s.

USB-1608G Series devices are powered by the +5 volt USB supply from your computer, and require no external power.

Functional block diagram

USB-1608G Series functions are illustrated in the block diagram shown here.

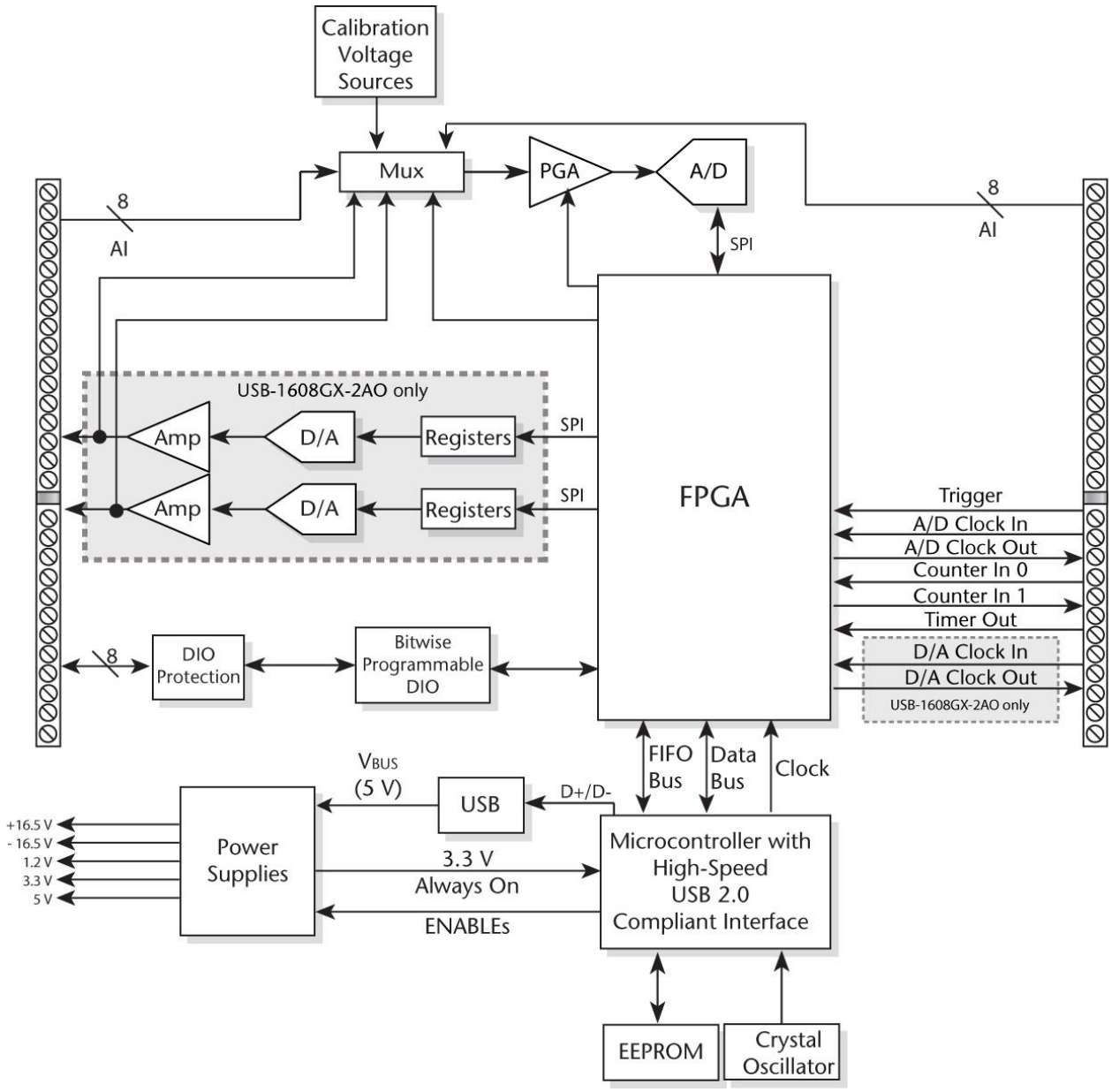

Figure 1. USB-1608G Series functional block diagram

Installing a USB-1608G Series Device

What comes with your shipment?

Verify that the following hardware components are included in the shipment:

Hardware

- USB-1608G Series device — USB-1608G, USB-1608GX, or USB-1608GX-2AO (shown below)

- USB cable (2 meter length)

Documentation

In addition to this hardware user's guide, a *Quick Start Guide* booklet is included with the USB-1608G Series shipment. This booklet provides an overview of the MCC DAQ software you received with the device, and includes information about installing the software.

Unpacking

As with any electronic device, take care while handling to avoid damage from static electricity. Before removing the USB-1608G Series from its packaging, ground yourself using a wrist strap or touch either the computer chassis or other grounded object to eliminate any stored static charge.

If the device is damaged, notify Measurement Computing Corporation immediately by phone, fax, or email.

- Phone: 508-946-5100 and follow the instructions for reaching Tech Support.
- Fax: 508-946-9500 to the attention of Tech Support
- Email: techsupport@mccdaq.com

For international customers, contact your local distributor. Refer to the International Distributors section on our web site at www.mccdaq.com/International.

Installing the software

Note: Before installing USB-1608G Series hardware, you must install the software you plan to use with the device.

The USB-1608G Series is supported by DAQFlex software and Universal Library software. You can install both software packages on your computer. However, you cannot run both software packages simultaneously with one USB-1608G Series device.

DAQFlex

Install DAQFlex software when you want to develop data acquisition applications that can be deployed across multiple operating systems and custom embedded systems.

DAQFlex software for each supported operating system is available from the DAQFlex download page at www.mccdaq.com/DAQFlexDL. Refer to the *DAQFlex Software User's Guide* at www.mccdaq.com/pdfs/manuals/DAQFlex%20Software.pdf for instructions about installing DAQFlex software.

Universal Library and InstaCal

Install Universal Library and InstaCal when you want to develop data acquisition applications using Windows programming languages.

Universal Library and InstaCal software are included on the CD that ships with the device. Refer to the *Quick Start Guide* booklet for instructions about installing Universal Library and InstaCal software.

Installing the hardware

Install the software before you install your device

A driver needed to run the USB-1608G Series device is installed when you install the software. Therefore, you need to install the software package you plan to use before you install the hardware.

For operation on a Windows operating system, we recommend that you run Windows Update to update your operating system with the latest USB drivers.

To connect a USB-1608G Series device to your system, turn on your computer and connect the USB cable to an available USB port on the computer or to an external USB hub connected to the computer. Connect the other end of the USB cable to the USB connector on the device. No external power is required.

When you connect the device for the first time to a computer running Windows, a **Found New Hardware** dialog opens when the operating system detects the device. The dialog closes after the device is installed.

A green **Status** LED indicates the device status. When the LED is on, the device is powered and ready for operation. When the LED is off, the device is not powered or did not initialize. Figure 3 on page 12 shows the location of the **Status** LED.

Mac OS X

When connecting the device to a computer installed with the Mac OS X operating system, the Status LED does not turn on until the device is configured with software.

Caution! Do not disconnect any device from the USB bus while the computer is communicating with USB-1608G Series hardware, or you may lose data and/or your ability to communicate with the device.

If the Status LED is off

If the **Status** LED is on but then turns off, the computer has lost communication with the USB-1608G Series device. To restore communication, disconnect the USB cable from the computer and then reconnect it. This should restore communication, and the LED should turn on.

Calibrating

Self-calibration

USB-1608G Series hardware supports self-calibration. Calibrate the USB-1608G Series device whenever the ambient temperature changes by more than ±10 °C from the last self-calibration. Use either InstaCal or the DAQFlex FlexTest utility to calibrate the device.

Factory calibration

The Measurement Computing Manufacturing Test department performs the initial factory calibration. Contact Measurement Computing for details about how to return your device and have it calibrated to the factory specifications.

Programming and developing applications

You can program and develop applications for the USB-1608G Series device using MCC DAQ software and DAQFlex software. OEM users can create a custom driver for use with the message-based firmware to interface with the device.

- Refer to the *Quick Start Guide* for information about the Universal Library and InstaCal.
- Refer to the DAQFlex Software User's Guide for information about DAQFlex software.
- Refer to the Message-based Firmware Specification for information about the message-based firmware.

Firmware updates

Your DAQ device contains firmware that can be updated in the field if required. Firmware is available for download at www.mccdaq.com/firmware.aspx.We recommend that you check this page periodically to see if an update to your device firmware is available.

Functional Details

Analog input modes

USB-1608G Series devices can acquire analog input data in two basic modes – software paced and hardware paced.

Software paced

You can acquire one analog sample at a time in software paced mode. You initiate the A/D conversion with a software command. The analog value is converted to digital data and returned to the computer. Repeat this procedure until you have the total number of samples that you want.

The sample rate in software paced mode is system-dependent and can range from 33 S/s to 4000 S/s.

Hardware paced

You can acquire data from up to 16 channels in hardware paced mode. The analog data is continuously acquired, converted to digital values, and written into the FIFO buffer on the device until you stop the scan. The FIFO buffer is serviced in blocks as the data is transferred from the FIFO buffer to the computer memory buffer. You start a continuous scan with either a software command or with an external hardware trigger event.

The maximum sampling rate in hardware paced mode from one to 16 channels is 500 kS/s aggregate for the USB-1608GX and USB-1608GX-2AO, and 250 kS/s for the USB-1608G.

Burst mode

When using the onboard pacer, you can enable burst mode for more precise timing between samples. When burst mode is enabled, each successive channel in a scan is sampled at the maximum A/D rate. This ensures that samples from each channel are taken as close as possible to the same absolute point in time. When burst mode is disabled, data is sampled at evenly spaced intervals, allowing maximum settling time and best amplitude accuracy. Multi-channel scanning with burst mode enabled and disabled is shown in Figure 2.

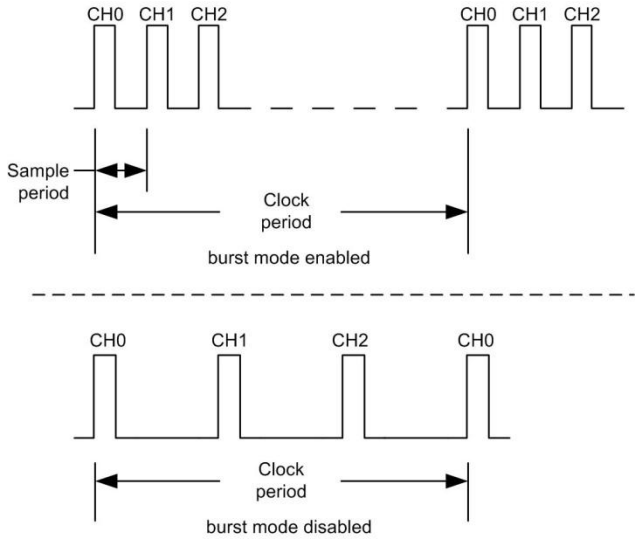

Figure 2. Multi-channel scan with burst mode enabled and disabled

The burst mode sample period is 2 µs on the USB-1608GX and USB-1608GX-2AO, and 4 µs on the USB-1608G.

You can trigger the acquisition with the external trigger, and control the clock period with the internal or external A/D pacer clock. Pacing from the external clock always operates with burst mode enabled.

External components

USB-1608G Series devices have the following external components (see Figure 3):

- USB connector
- LEDs
- Screw terminals

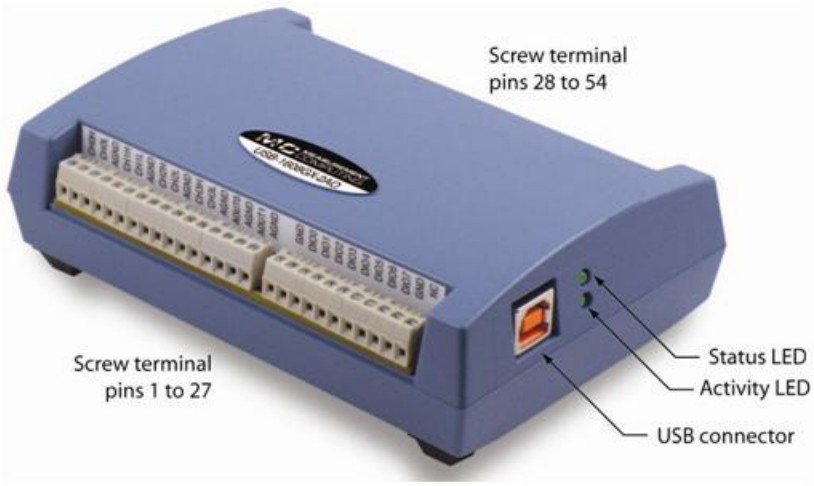

Figure 3. USB-1608G Series device external components

USB connector

The USB connector provides +5 V power and communication. No external power supply is required.

LEDs

USB-1608G Series devices have two LEDs – **Status** and **Activity**.

- The **Status** LED turns on when the device is detected and installed on the computer.
- The **Activity** LED blinks when data is transferred, and is off otherwise.

Figure 3 shows the location of each LED.

Screw terminals

The USB-1608G Series device screw terminals provide the following connections:

- 16 SE (**CH0** to **CH15**) or eight DIFF (**CH0H/CH0L** to **CH7H/CH7L**) analog input connections
- Eight digital I/O connections (**DIO0** to **DIO7**)
- Two analog output connections (**AOUT0**, **AOUT1**) – USB-1608GX-2AO *only*
- One external clock input (**AICKI**) and one external clock output (**AICKO**) for analog inputs
- One external clock input (**AOCKI**) and one external clock output (**AOCKO**) for analog outputs – USB-1608GX-2AO *only*
- One digital trigger input (**TRIG**)
- Two counter inputs (**CTR0**, **CTR1**)
- One timer output (**TMR**)
- One power output (**+5V**)
- 13 analog ground (**AGND**) and five digital ground (**GND**) connections

SE pinout locations are shown in Figure 4. Diff pinout locations are shown in Figure 5.

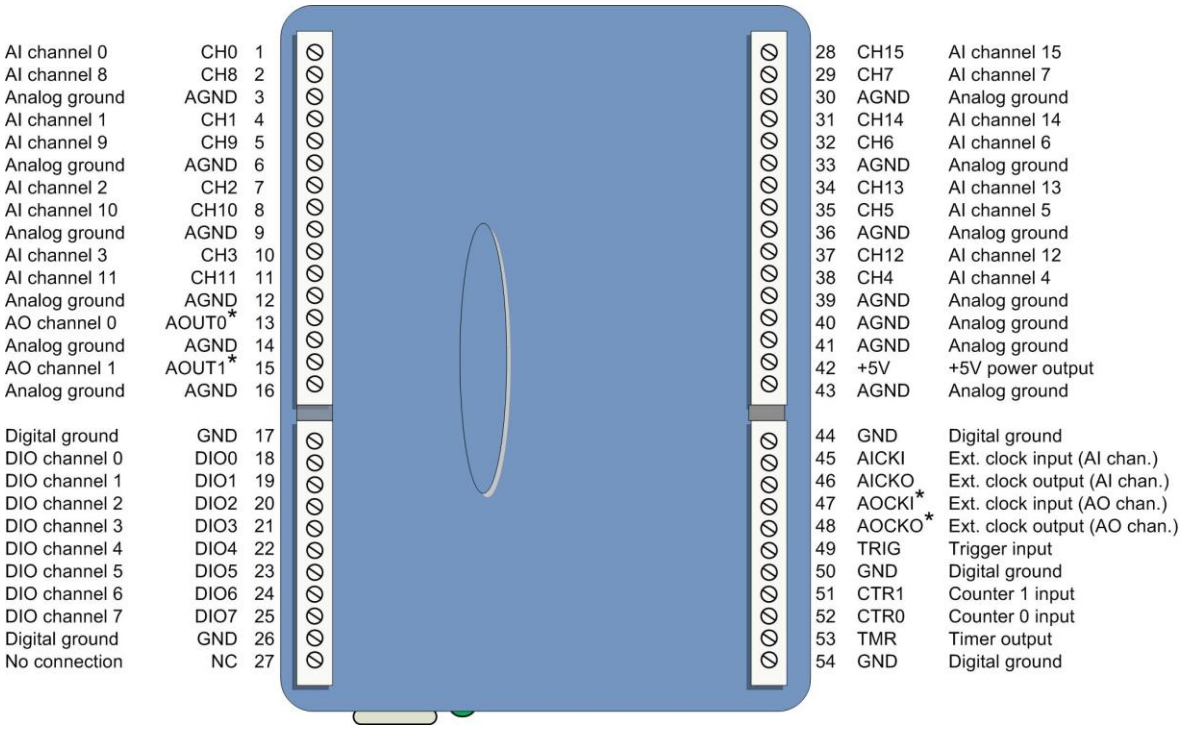
AI channel 0 CH0 1
AI channel 8 CH8 2
Analog ground AGND 3
AI channel 1 CH1 4
AI channel 9 CH9 5
Analog ground AGND 6
AI channel 2 CH2 7
AI channel 10 CH10 8
Analog ground AGND 9
AI channel 3 CH3 10
AI channel 11 CH11 11
Analog ground AGND 12
AO channel 0 AOUT0* 13
Analog ground AGND 14
AO channel 1 AOUT1* 15
Analog ground AGND 16
Digital ground GND 17
DIO channel 0 DIO0 18
DIO channel 1 DIO1 19
DIO channel 2 DIO2 20
DIO channel 3 DIO3 21
DIO channel 4 DIO4 22
DIO channel 5 DIO5 23
DIO channel 6 DIO6 24
DIO channel 7 DIO7 25
Digital ground GND 26
No connection NC 27
28 CH15 AI channel 15
29 CH7 AI channel 7
30 AGND Analog ground
31 CH14 AI channel 14
32 CH6 AI channel 6
33 AGND Analog ground
34 CH13 AI channel 13
35 CH5 AI channel 5
36 AGND Analog ground
37 CH12 AI channel 12
38 CH4 AI channel 4
39 AGND Analog ground
40 AGND Analog ground
41 AGND Analog ground
42 +5V +5V power output
43 AGND Analog ground
44 GND Digital ground
45 AICKI Ext. clock input (AI chan.)
46 AICKO Ext. clock output (AI chan.)
47 AOCKI* Ext. clock input (AO chan.)
48 AOCKO* Ext. clock output (AO chan.)
49 TRIG Trigger input
50 GND Digital ground
51 CTR1 Counter 1 input
52 CTR0 Counter 0 input
53 TMR Timer output
54 GND Digital ground

Figure 4. SE mode pinout

* USB-1608GX-2AO only. "NC" (no connection) on the USB-1608G and USB-1608GX. Do not connect anything to pins labeled "NC".

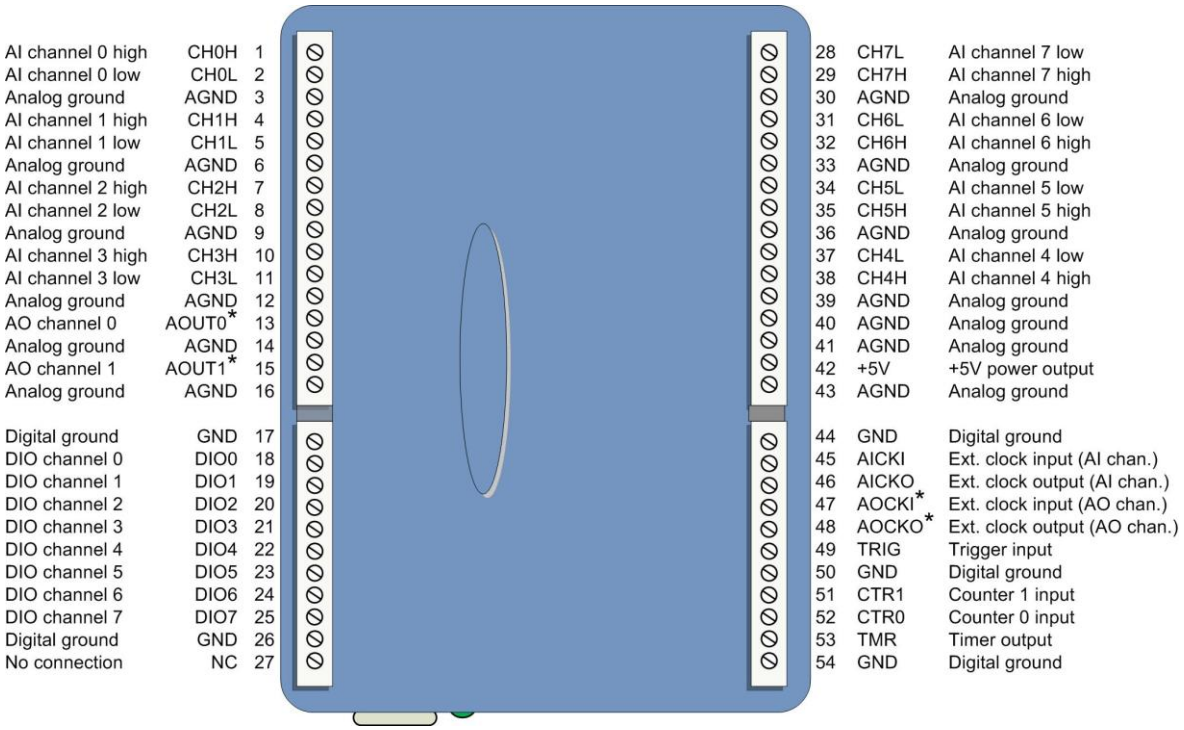
AI channel 0 high CH0H 1
AI channel 0 low CH0L 2
Analog ground AGND 3
AI channel 1 high CH1H 4
AI channel 1 low CH1L 5
Analog ground AGND 6
AI channel 2 high CH2H 7
AI channel 2 low CH2L 8
Analog ground AGND 9
AI channel 3 high CH3H 10
AI channel 3 low CH3L 11
Analog ground AGND 12
AO channel 0 AOUT0* 13
Analog ground AGND 14
AO channel 1 AOUT1* 15
Analog ground AGND 16
Digital ground GND 17
DIO channel 0 DIO0 18
DIO channel 1 DIO1 19
DIO channel 2 DIO2 20
DIO channel 3 DIO3 21
DIO channel 4 DIO4 22
DIO channel 5 DIO5 23
DIO channel 6 DIO6 24
DIO channel 7 DIO7 25
Digital ground GND 26
No connection NC 27
28 CH7L AI channel 7 low
29 CH7H AI channel 7 high
30 AGND Analog ground
31 CH6L AI channel 6 low
32 CH6H AI channel 6 high
33 AGND Analog ground
34 CH5L AI channel 5 low
35 CH5H AI channel 5 high
36 AGND Analog ground
37 CH4L AI channel 4 low
38 CH4H AI channel 4 high
39 AGND Analog ground
40 AGND Analog ground
41 AGND Analog ground
42 +5V +5V power output
43 AGND Analog ground
44 GND Digital ground
45 AICKI Ext. clock input (AI chan.)
46 AICKO Ext. clock output (AI chan.)
47 AOCKI* Ext. clock input (AO chan.)
48 AOCKO* Ext. clock output (AO chan.)
49 TRIG Trigger input
50 GND Digital ground
51 CTR1 Counter 1 input
52 CTR0 Counter 0 input
53 TMR Timer output
54 GND Digital ground

Figure 5. DIFF mode pinout

* USB-1608GX-2AO only. "NC" (no connection) on the USB-1608G and USB-1608GX. Do not connect anything to pins labeled "NC".

Signal connections

Analog input

You can configure the analog inputs for SE or DIFF mode. The input voltage range is software selectable for ±10 V, ±5 V, ±2 V, or ±1 V.

With SE mode, connect up to 16 inputs to screw terminals **CH0** to **CH15**. SE mode requires two wires:

- Connect one wire to the signal you want to measure (**CHx**).
- Connect one wire to the analog ground reference (**AGND**).

Refer to Figure 4 on page 13 for the location of the SE inputs.

With DIFF mode, connect up to eight differential inputs to screw terminals **CH0H/CH0L** to **CH7H/CH7L**. DIFF mode requires two wires plus a ground reference:

- Connect one wire to the high/positive signal (**CHxH**).
- Connect one wire to the low/negative signal (**CHxL**).
- Connect one wire to the analog ground reference (**AGND**).

Refer to Figure 5 on page 13 for the location of the DIFF inputs.

Floating voltage source

When connecting DIFF voltage inputs to a "floating" voltage source, make sure the DIFF input channel has a DC return path to ground. To create this path, connect a resistor from each low channel input to an AGND pin. A value of approximately 100 kΩ can be used for most applications.

Leave unused input channels either floating or tied to an AGND terminal. Source impedances should be kept as small as possible to avoid settling time and accuracy errors.

Figure 6 shows DIFF channels 0-3 connected to a ground path resistor.

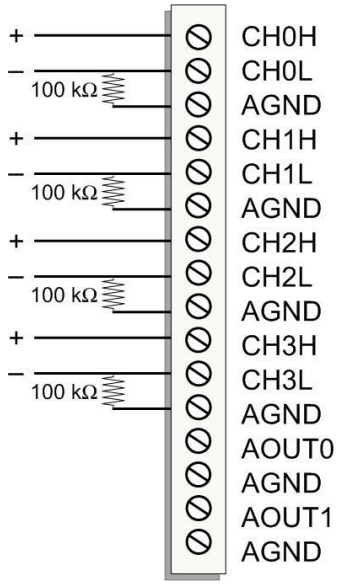

Figure 6. DIFF connections with ground path resistor

Channel-Gain queue

The USB-1608G Series channel-gain queue feature allows you to configure a list of channels, modes, and gains for each scan. The settings are stored in a channel-gain queue list that is written to local memory on the device.

The channel-gain queue list contains one or more channel numbers, modes, and range settings. You can configure up to 16 elements. The channels can be listed in any order, and can include duplicate channels for sampling at different ranges.

An example of a 4-element list is shown in the table below.

Sample channel gain queue list

Element	Channel	Range	Mode
0	CH5	BIP5V	SE
1	CH1	BIP10V	DIFF
2	CH15	BIP1V	SE
3	CH5	BIP5V	SE

Carefully match the gain to the expected voltage range on the associated channel or an over range condition may occur. Although this condition does not damage the device, it does produce a useless full-scale reading, and can introduce a long recovery time due to saturation of the input channel.

For more information about analog signal connections

For more information about analog input connections, refer to the *Guide to Signal Connections* (this document is available on our web site at www.mccdaq.com/signals/signals.pdf).

Analog output (USB-1608GX-2AO only)

The USB-1608GX-2AO has two 16-bit analog outputs (**AOUT0** and **AOUT1**). Both outputs can be updated simultaneously at a rate of 250 kS/s per channel. One output can be updated at a rate of 500 kS/s. The output range is fixed at ±10 V. The outputs default to 0 V when the host computer is shut down or suspended, or when a reset command is issued to the device.

External clock I/O

USB-1608G Series devices provide one external clock input (**AICKI**) and one external clock output (**AICKO**) for analog inputs.

The USB-1608GX-2AO also has one external clock input (**AOCKI**) and one external clock output (**AOCKO**) for analog outputs.

- You can connect an external clock signal to **AICKI** and/or **AOCKI**.
  When using an external clock, **AICKO** outputs the pulse generated from **AICKI**.
  When using a USB-1608GX-2AO, the **AOCKO** pin outputs the pulse generated from **AOCKI**.
- When using the internal clock, **AICKO** outputs the ADC scan clock.
  When using a USB-1608GX-2AO, **AOCKO** outputs the DAC scan clock.

Digital I/O

You can connect up to eight digital I/O lines to **DIO0** through **DIO7**. Each digital channel is individually configurable for input or output. The digital I/O terminals can detect the state of any TTL-level input. Refer to the schematic shown in Figure 7.

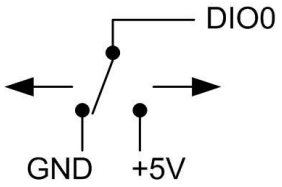

Figure 7. Schematic showing switch detection by digital channel DIO0

If you set the switch to the +5 V input, DIO0 reads *TRUE* (1). If you move the switch to GND, DIO0 reads *FALSE* (0).

Internal pull-up/down configuration

Unconnected inputs are pulled low by default to 0 V through 47 kΩ resistors via jumper **W1** on the circuit board. The pull-up/pull-down voltage is common to all 47 kΩ resistors. Complete the following steps to configure these inputs to pull high (+5V).

Caution! The discharge of static electricity can damage some electronic components. Before removing the USB-1608G Series device from its housing, ground yourself using a wrist strap or touch the computer chassis or other grounded object to eliminate any stored static charge.

1. Turn the device over and rest the top of the housing on a flat, stable surface.
2. Peel off the four rubber feet on the bottom of the device to access the screws.
3. Remove the four screws from the bottom of the device.
4. Hold both the top and bottom sections together, turn the device over and rest it on the surface, then carefully remove the top section of the case to expose the circuit board.
5. Configure jumper **W1** for either pull-up or pull-down. The jumper is configured by default for pull-down. Figure 8 shows the location of the jumper on the board.

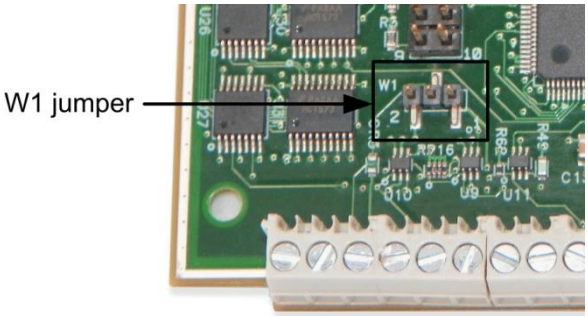

Figure 8. W1 jumper location

Figure 9 shows the jumper configured for pull-up and pull-down.

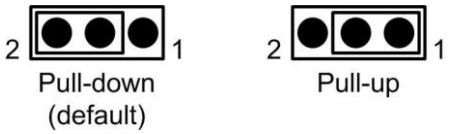

Figure 9. W1 jumper configurations

6. Replace the top section of the case, and fasten it to the bottom section with the four screws. Replace the rubber feet onto each screw.

For more information about digital signal connections

For general information about digital signal connections and digital I/O techniques, refer to the *Guide to Signal Connections* (available on our web site at www.mccdaq.com/signals/signals.pdf).

Trigger input

The **TRIG** terminal is an external digital trigger input. The trigger mode is software selectable for edge or level sensitive.

- Edge sensitive mode is configurable for rising or falling edge.
- Level sensitive mode is configurable for high or low level.

The default setting at power up is edge sensitive, rising edge.

Retrigger mode

Retrigger mode lets you set up repetitive analog input or output trigger events. The trigger is automatically re-armed after it is activated. Use software to set the A/D or D/A trigger count (the number of samples you want per trigger).

Counter input

The **CTR0** and **CTR1** terminals are 32-bit event counters that can accept frequency inputs up to 20 MHz. The internal counter increments when the TTL levels transition from low to high.

Timer output

The **TMR** terminal is a pulse width modulation (PWM) timer output that can generate a pulse output with a programmable frequency in the range of 0.0149 Hz to 32 MHz. The timer output parameters are software selectable. Figure 10 shows the timer output schematic.

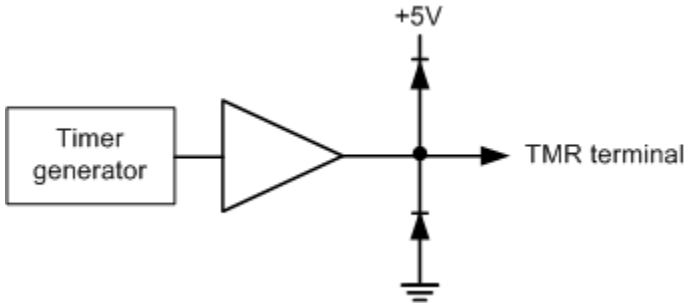

Figure 10. Timer output schematic

Power output

The **+5V** terminal can output up to 10 mA maximum. You can use this terminal to supply power to external devices or circuitry.

Caution! The **+5V** terminal is an output. Do not connect to an external power supply or you may damage the device and possibly the computer.

Ground

The analog ground (**AGND**) terminals provide a common ground for all analog channels.

The digital ground (**GND**) terminals provide a common ground for the digital, counter, timer, and clock channels and the power terminal.

Mechanical drawings

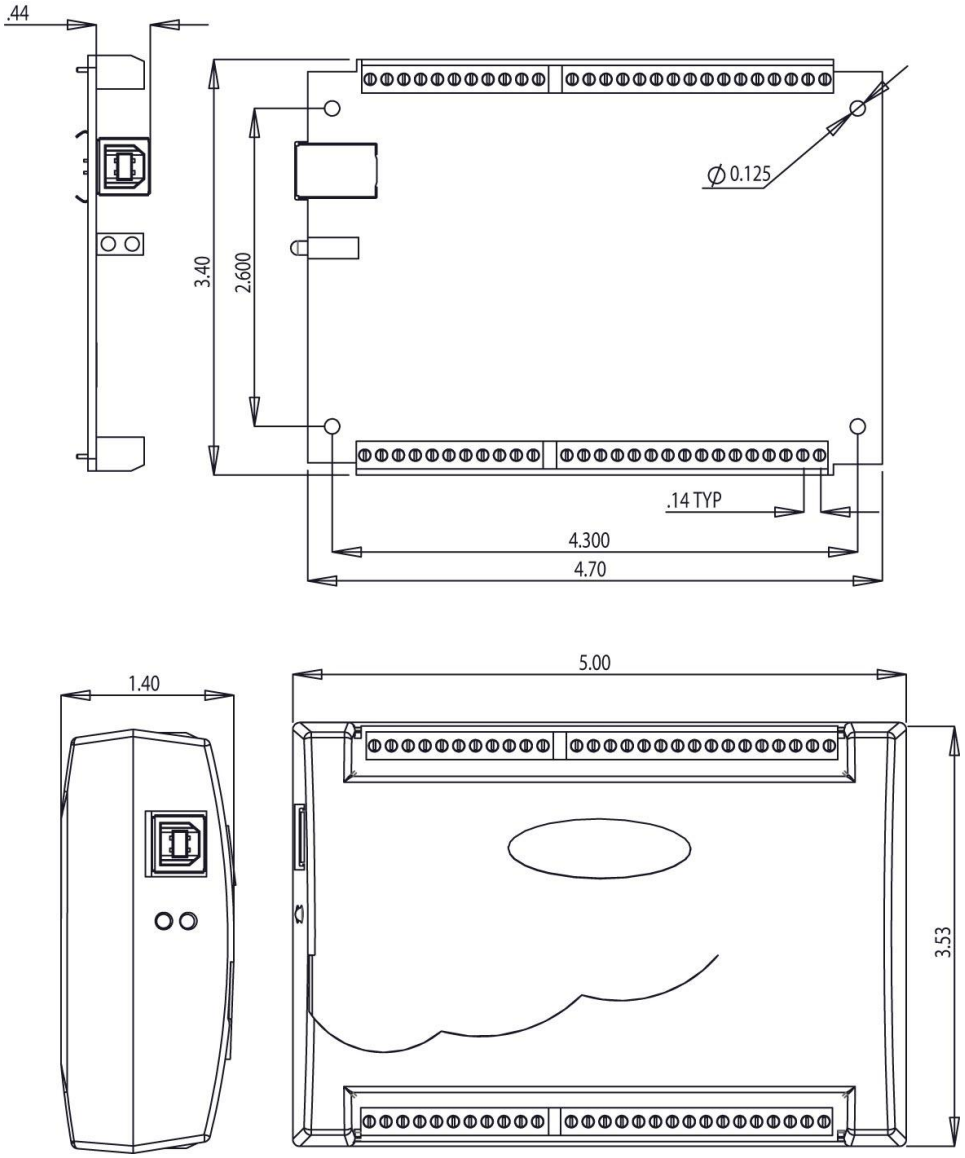

Figure 11. USB-1608G Series device circuit board (top) and enclosure dimensions

Specifications

All specifications are subject to change without notice.
Typical for 25 °C unless otherwise specified.
Specifications in *italic* text are guaranteed by design.

Analog input

Table 1. General analog input specifications

Parameter	Condition	Specification
A/D converter type		Successive approximation
ADC resolution		16 bits
Number of channels		8 differential, 16 single-ended Software-selectable
Input voltage range		±10 V, ±5 V, ±2 V, ±1 V Software-selectable per channel
Absolute max input voltage	*CHx relative to AGND*	▪ *±25 V max (power on)* ▪ *±15 V max (power off)*
Input impedance		▪ *1 GΩ (power on)* ▪ *820 Ω (power off)*
Input bias current		*±10 nA*
Input bandwidth	All input ranges, small signal (–3 dB)	USB-1608G: 750 kHz USB-1608GX: 870 kHz USB-1608GX-2AO: 870 kHz
Input capacitance		*60 pf*
Max working voltage (signal + common mode)		±10.2 V max relative to AGND
Common mode rejection ratio	(f_{IN} = 60 Hz, all input ranges)	86 dB
Crosstalk	Adjacent differential mode channels, DC to 100 kHz	–75 dB
Input coupling		DC
Sampling rate		USB-1608G: 0.0149 Hz to 250 kHz USB-1608GX: 0.0149 Hz to 500 kHz USB-1608GX-2AO: 0.0149 Hz to 500 kHz Software-selectable
Trigger source		TRIG (see External trigger on page 22)
Sample clock source		Internal A/D clock or external A/D clock (AICKI pin)
Burst mode		USB-1608G: 4 µs USB-1608GX: 2 µs USB-1608GX-2AO: 2 µs Software-selectable using the internal A/D clock; always enabled when using the external clock (AICKI pin).
Throughput	Software paced	33 to 4000 S/s typ, system dependent
	Hardware paced	USB-1608G: 250 kS/s max USB-1608GX: 500 kS/s max USB-1608GX-2AO: 500 kS/s max
Channel gain queue	Up to 16 elements	Software-selectable range for each channel
Warm-up time		15 minutes min

Accuracy

Analog input DC voltage measurement accuracy

Table 2. DC Accuracy components and specifications. All values are (±)

Range	Gain error (% of reading)	Offset error (µV)	INL error (% of range)	Absolute accuracy at Full Scale (µV)	Gain temperature coefficient (% reading/°C)	Offset temperature coefficient (µV/°C)
±10 V	0.024	915	0.0076	4075	0.0014	47
±5 V	0.024	686	0.0076	2266	0.0014	24
±2 V	0.024	336	0.0076	968	0.0014	10
±1 V	0.024	245	0.0076	561	0.0014	5

Noise performance

For the peak-to-peak noise distribution test, a differential input channel is connected to AGND at the input terminal block, and 32,000 samples are acquired at the maximum rate available at each setting.

Table 3. Noise performance specifications

Range	Counts	LSBrms
±10 V	6	0.91
±5 V	6	0.91
±2 V	7	1.06
±1 V	9	1.36

Settling time

Settling time is defined as the accuracy that can be expected after one conversion when switching from a channel with a DC input at one extreme of full scale to another channel with a DC input at the other extreme of full scale. Both input channels are configured for the same input range.

USB-1608GX-2AO, USB-1608GX

Table 4. Input settling time specifications in µS, typical

Range	2 µS settling accuracy (% FSR)	4 µS settling accuracy (% FSR)	9 µS settling accuracy (% FSR)
±10 V	0.1251	0.0031	0.0015
±5 V	0.0687	0.0031	0.0015
±2 V	0.0687	0.0031	0.0015
±1 V	0.0687	0.0031	0.0015

USB-1608G

Table 5. Input settling time specifications in µS, typical

Range	4 µS settling accuracy (% FSR)	6 µS settling accuracy (% FSR)	±10 µS settling accuracy (% FSR)
±10 V	0.0061	0.0031	0.0015
±5 V	0.0061	0.0031	0.0015
±2 V	0.0061	0.0031	0.0015
±1 V	0.0061	0.0031	0.0015

Analog output (USB-1608GX-2AO only)

Table 6. Analog output specifications

Parameter	Condition	Specification
Number of channels		2
Resolution		16 bits
Output ranges	Calibrated	±10 V
Output transient	Host computer is reset, powered on, suspended, or a reset command is issued to the device	Duration: 500 µs Amplitude: 2 V p-p
	Powered off	Duration: 10 ms Amplitude: 7 V peak
Differential non-linearity		±0.25 LSB typ ±1 LSB max
Output current	AOUTx pins	±3.5 mA max
Output short-circuit protection	AOUTx connected to AGND	Unlimited duration
Output coupling		DC
Power on and reset state		DACs cleared to zero-scale: 0 V, ±50 mV
Output noise		30 µVrms
Sample clock source		Internal D/A clock or external D/A clock (AOCKI pin)
Output update rate		500 kHz / (number of channels in scan)
Settling time	*To rated accuracy, 10 V step*	*40 µs*
Slew rate		*9 V/µs*
Throughput	Software paced	33 to 4000 S/s typ, system-dependent
	Hardware paced	500 kS/s max, system-dependent

Note 1: Leave unused AOUTx output channels disconnected.

Note 2: AOUTx defaults to 0 V whenever the host computer is reset, powered on, suspended, or a reset command is issued to the device.

Table 7. Calibrated absolute accuracy specifications

Range	Absolute accuracy (±LSB)
±10 V	16.0

Table 8. Calibrated absolute accuracy components specifications

Range	% of reading	Offset (±mV)	Offset tempco (µV/°C)	Gain tempco (ppm of range/°C)
±10 V	±0.0183	1.831	12.7	13

Table 9. Relative accuracy specifications (±LSB)

Range	Relative accuracy (INL)
±10 V	4.0 typ

Analog input/output calibration

Table 10. Analog input/output calibration specifications

Parameter	Specification
Recommended warm-up time	15 minutes min
Calibration method	Self-calibration (firmware)
Calibration interval	1 year (factory calibration)
AI calibration reference	+5 V, ±2.5 mV max. Actual measured values stored in EEPROM.
	Tempco: 5 ppm/°C max
	Long term stability: 15 ppm/1000 hours
AO calibration procedure (USB-1608GX-2AO only)	The analog output pins are internally routed to the analog input circuit. For best calibration results, disconnect any AOUTx connections at the terminal block pins prior to performing AOUT calibration.

Digital input/output

Table 11. Digital input/output specifications

Parameter	Specification
Digital type	CMOS
Number of I/O	8
Configuration	Each bit may be configured as input (power on default) or output
Pull-up configuration	The port has 47 kΩ resistors configurable as pull-ups or pull-downs (default) via internal jumper (W1).
Digital I/O transfer rate (system-paced)	33 to 8000 port reads/writes or single bit reads/writes per second typ, system dependent.
Input high voltage	2.0 V min 5.5 V absolute max
Input low voltage	0.8 V max –0.5 V absolute min 0 V recommended min
Output high voltage	4.4 V min (IOH = –50 µA) 3.76 V min (IOH = –2.5 mA)
Output low voltage	0.1 V max (IOL = 50 µA) 0.44 V max (IOL = 2.5 mA)
Output current	±2.5 mA max

External trigger

Table 12. External trigger specifications

Parameter	Specification
Trigger source	TRIG input
Trigger mode	Software programmable for edge or level sensitive, rising or falling edge, high or low level. Power on default is edge sensitive, rising edge.
Trigger latency	1 µs + 1 clock cycle max
Trigger pulse width	100 ns min
Input type	Schmitt trigger, 33 Ω series resistor and 49.9 kΩ pull-down to ground
Schmitt trigger hysteresis	0.4 V to 1.2 V
Input high voltage	2.2 V min 5.5 V absolute max
Input low voltage	1.5 V max –0.5 V absolute min 0 V recommended min

External clock input/output

Table 13. External clock I/O specifications

Parameter	Specification
Terminal names	AICKI, AICKO, AOCKI, AOCKO (USB-1608GX-2AO only)
Terminal types	AxCKI: Input, active on rising edge AxCKO: Output, power on default is 0 V, active on rising edge
Terminal descriptions	AxCKI: Receives sampling clock from external source
	AxCKO: Outputs the internal sampling clock (D/A or A/D clock) or the pulse generated from AxCKI when in external clock mode.
Input clock rate	USB-1608G: 250 kHz max USB-1608GX: 500 kHz max USB-1608GX-2AO: 500 kHz max
Clock pulse width	AxCKI: 400 ns min
	AxCKO: 400 ns min
Input type	Schmitt trigger, 33 Ω series resistor, 47 kΩ pull-down to ground
Schmitt trigger hysteresis	0.4 V to 1.2 V
Input high voltage	2.2 V min 5.5 V absolute max
Input low voltage	1.5 V max –0.5 V absolute min 0 V recommended min
Output high voltage	4.4 V min (IOH = –50 µA) 3.76 V min (IOH = –2.5 mA)
Output low voltage	0.1 V max (IOL = 50 µA) 0.44 V max (IOL = 2.5 mA)
Output current	±2.5 mA max

Counter

Table 14. Counter specifications

Parameter	Specification
Terminal names	CTR0, CTR1
Number of channels	2 channels
Resolution	32-bit
Counter type	Event counter
Input type	Schmitt trigger, 33 Ω series resistor, 47 kΩ pull-down to ground
Input source	CTR0 (pin 52) CTR1 (pin 51)
Counter read/writes rates (software paced)	33 to 8000 reads/writes per second typ, system dependent
Input high voltage	2.2 V min, 5.5 V max
Input low voltage	1.5 V max, –0.5 V min
Schmitt trigger hysteresis	0.4 V min, 1.2 V max
Input frequency	20 MHz, max
High pulse width	*25 ns, min*
Low pulse width	*25 ns, min*

Timer

Table 15. Timer specifications

Parameter	Specification
Terminal name	TMR
Timer type	PWM output with count, period, delay, and pulse width registers
Output value	Default state is idle low with pulses high, Software-selectable output invert
Internal clock frequency	64 MHz
Register widths	32-bit
High pulse width	*15.625 ns min*
Low pulse width	*15.625 ns min*
Output high voltage	4.4 V min (IOH = –50 µA) 3.76 V min (IOH = –2.5 mA)
Output low voltage	0.1 V max (IOL = 50 µA) 0.44 V max (IOL = 2.5 mA)
Output current	±2.5 mA max

Memory

Table 16. Memory specifications

Parameter	Specification
Data FIFO	4 kS analog input/2 kS analog output
Non-volatile memory	32 KB (28 KB firmware storage, 4 KB calibration/user data)

Power

Table 17. Power specifications

Parameter	Condition	Specification
Supply current (Note 3)	Quiescent current	USB-1608G: 230 mA USB-1608GX: 230 mA USB-1608GX-2AO: 260 mA
+5 V user output voltage range	Available at terminal block pin 42	4.5 V min to 5.25 V max
+5 V user output current	Available at terminal block pin 42	10 mA max

Note 3: This is the total quiescent current requirement for the device that includes up to 10 mA for the Status LED. This does not include any potential loading of the digital I/O bits, +5V terminal, or the AOUTx outputs (USB-1608GX-2AO only).

USB

Table 18. USB specifications

Parameter	Specification
USB device type	USB 2.0 (high-speed)
Device compatibility	USB 1.1, USB 2.0
USB cable type	A-B cable, UL type AWM 2527 or equivalent. (min 24 AWG VBUS/GND, min 28 AWG D+/D–)
USB cable length	3 m (9.84 ft) max

Environmental

Table 19. Environmental specifications

Parameter	Specification
Operating temperature range	0 °C to 55 °C max
Storage temperature range	–40 °C to 85 °C max
Humidity	0% to 90% non-condensing max

Mechanical

Table 20. Mechanical specifications

Parameter	Specification
Dimensions (L × W × H)	127 × 89.9 × 35.6 mm (5.00 × 3.53 × 1.40 in.)
User connection length	3 m (9.84 ft) max

Screw terminal connector

Table 21. Screw terminal connector specifications

Parameter	Specification
Connector type	Screw terminal
Wire gauge range	16 AWG to 30 AWG

Differential mode pinout

Table 22. 8-channel differential mode pinout

Pin	Signal name	Pin description	Pin	Signal name	Pin description
1	CH0H	Channel 0 HI	28	CH7L	Channel 7 LO
2	CH0L	Channel 0 LO	29	CH7H	Channel 7 HI
3	AGND	Analog ground	30	AGND	Analog ground
4	CH1H	Channel 1 HI	31	CH6L	Channel 6 LO
5	CH1L	Channel 1 LO	32	CH6H	Channel 6 HI
6	AGND	Analog ground	33	AGND	Analog ground
7	CH2H	Channel 2 HI	34	CH5L	Channel 5 LO
8	CH2L	Channel 2 LO	35	CH5H	Channel 5 HI
9	AGND	Analog ground	36	AGND	Analog ground
10	CH3H	Channel 3 HI	37	CH4L	Channel 4 LO
11	CH3L	Channel 3 LO	38	CH4H	Channel 4 HI
12	AGND	Analog ground	39	AGND	Analog ground
13	AOUT0 (Note 4)	Analog output 0	40	AGND	Analog ground
14	AGND	Analog ground	41	AGND	Analog ground
15	AOUT1 (Note 4)	Analog output 1	42	+5V	+5V output
16	AGND	Analog ground	43	AGND	Analog ground
	empty			empty	
17	GND	Digital ground	44	GND	Digital ground
18	DIO0	Digital input/output	45	AICKI	AI clock input
19	DIO1	Digital input/output	46	AICKO	AI clock output
20	DIO2	Digital input/output	47	AOCKI (Note 4)	AO clock input
21	DIO3	Digital input/output	48	AOCKO (Note 4)	AO clock output
22	DIO4	Digital input/output	49	TRIG	Trigger input
23	DIO5	Digital input/output	50	GND	Digital ground
24	DIO6	Digital input/output	51	CTR1	Counter 1
25	DIO7	Digital input/output	52	CTR0	Counter 0
26	GND	Digital ground	53	TMR	Timer output
27	NC	No connect	54	GND	Digital ground

Note 4: USB-1608GX-2AO only. "NC" (no connection) on the USB-1608G and USB-1608GX.

Single-ended mode pinout

Table 23. 16-channel single-ended mode pinout

Pin	Signal name	Pin description	Pin	Signal name	Pin description
1	CH0	Channel 0	28	CH15	Channel 15
2	CH8	Channel 8	29	CH7	Channel 7
3	AGND	Analog ground	30	AGND	Analog ground
4	CH1	Channel 1	31	CH14	Channel 14
5	CH9	Channel 9	32	CH6	Channel 6
6	AGND	Analog ground	33	AGND	Analog ground
7	CH2	Channel 2	34	CH13	Channel 13
8	CH10	Channel 10	35	CH5	Channel 5
9	AGND	Analog ground	36	AGND	Analog ground
10	CH3	Channel 3	37	CH12	Channel 12
11	CH11	Channel 11	38	CH4	Channel 4
12	AGND	Analog ground	39	AGND	Analog ground
13	AOUT0 (Note 5)	Analog output 0	40	AGND	Analog ground
14	AGND	Analog ground	41	AGND	Analog ground
15	AOUT1 (Note 5)	Analog output 1	42	+5V	+5V output
16	AGND	Analog ground	43	AGND	Analog ground
	empty			empty	
17	GND	Digital ground	44	GND	Digital ground
18	DIO0	Digital input/output	45	AICKI	AI clock input
19	DIO1	Digital input/output	46	AICKO	AI clock output
20	DIO2	Digital input/output	47	AOCKI (Note 5)	AO clock input
21	DIO3	Digital input/output	48	AOCKO (Note 5)	AO clock output
22	DIO4	Digital input/output	49	TRIG	Trigger input
23	DIO5	Digital input/output	50	GND	Digital ground
24	DIO6	Digital input/output	51	CTR1	Counter 1
25	DIO7	Digital input/output	52	CTR0	Counter 0
26	GND	Digital ground	53	TMR	Timer output
27	NC	No connect	54	GND	Digital ground

Note 5: USB-1608GX-2AO only. "NC" (no connection) on the USB-1608G and USB-1608GX.

CE Declaration of Conformity

Manufacturer:	Measurement Computing Corporation
Address:	10 Commerce Way Suite 1008 Norton, MA 02766 USA
Category:	Electrical equipment for measurement, control and laboratory use.

Measurement Computing Corporation declares under sole responsibility that the products

USB-1608G, USB-1608GX, USB-1608GX-2AO

to which this declaration relates is in conformity with the relevant provisions of the following standards or other documents:

EC EMC Directive 2004/108/EC: General Requirements, EN 61326-1:2006 (IEC 61326-1:2005).

Emissions:

- EN 55011 (2007) / CISPR 11(2003): Radiated emissions: Group 1, Class A
- EN 55011 (2007) / CISPR 11(2003): Conducted emissions: Group 1, Class A

Immunity: EN 61326-1:2006, Table 3.

- IEC 61000-4-2 (2001): Electrostatic Discharge immunity.
- IEC 61000-4-3 (2002): Radiated Electromagnetic Field immunity.
-
- To maintain compliance to the standards of this declaration, the following conditions must be met.
-
- The host computer, peripheral equipment, power sources, and expansion hardware must be CE compliant.
- All I/O cables must be shielded, with the shields connected to ground.
- I/O cables must be less than 3 meters (9.75 feet) in length.
- The host computer must be properly grounded.
- The host computer must be USB 2.0 compliant.
- Equipment must be operated in a controlled electromagnetic environment as defined by Standards EN 61326-1:2006, or IEC 61326-1:2005.
-

Note: Data acquisition equipment may exhibit noise or increased offsets when exposed to high RF fields (>1V/m) or transients.

Declaration of Conformity based on tests conducted by Chomerics Test Services, Woburn, MA 01801, USA in October, 2010. Test records are outlined in Chomerics Test Report #EMI5736.10.

We hereby declare that the equipment specified conforms to the above Directives and Standards.

Carl Haapaoja, Director of Quality Assurance

Measurement Computing Corporation
10 Commerce Way
Suite 1008
Norton, Massachusetts 02766
(508) 946-5100
Fax: (508) 946-9500
E-mail: info@mccdaq.com
www.mccdaq.com